

Characterising effective eLearning resources

Allison Littlejohn ^a, Isobel Falconer ^{a,*}, Lou McGill ^b

^a *Caledonian Academy, Glasgow Caledonian University, Cowcaddens Road, Glasgow G4 0BA, United Kingdom*

^b *JISC, United Kingdom*

Received 13 July 2006; accepted 1 August 2006

Abstract

The widespread availability of digital learning resources in a variety of media formats offers the possibility to make a profound difference in education. This potential has not been fully realised for range of interrelated reasons. In this paper we study the key characteristics of learning resources that have proved effective in changing learning and teaching, and relate them to existing frameworks for understanding resources. We outline the relationships between resources, their users, and the way they are used, and explore issues that influence practitioners in choosing a particular resource. Our study is based on a review of resources for e-learning and chemistry in post-compulsory education, undertaken for the UK Joint Information Systems Committees (JISC), as part of a wider study examining ‘The Effectiveness of Resources, Tools and Support Services used by Tutors in Designing and Delivering E-Learning Activities’.

© 2006 Elsevier Ltd. All rights reserved.

Keywords: Media in education; Teaching/learning strategies; Improving classroom teaching; Applications in subject areas; Authoring tools and methods

1. Introduction

The past 10 years have seen dramatic changes in Higher Education in terms of increased access to education, lifelong learning, increased choice in areas of study and the personalisation of learning (CIHE, 2002; DFES, 2001). To advance across all four domains seems to necessitate incompatible changes to the learning process, as practitioners offer individualised learning to a larger, more diverse student base. To achieve this cost effectively and without overwhelming practitioners requires new approaches to teaching and learning coupled with access to a wide range of resources: practitioners need to be able to source and share materials, adapt and contextualise them to suit individual needs, and use them across a variety of educational models.

In this paper we study the key characteristics of, mainly digital, learning resources that render them useful for teaching and learning, and relate them to existing frameworks for understanding resources. We outline the relationships between resources, their users, and the way they are used, and explore issues that influence practitioners in choosing a particular resource.

* Corresponding author. Tel.: +44 141 331 4808.

E-mail address: isobel.falconer@gcal.ac.uk (I. Falconer).

Our study is based on a report commissioned by the UK Joint Information Systems Committees (JISC), as part of a wider study examining ‘The Effectiveness of Resources, Tools and Support Services used by Tutors in Designing and Delivering E-Learning Activities’. The study reviewed a range of materials from one subject domain (eLearning practice) to determine baseline characteristics of resources that are known to have positively influenced practice. These materials (Littlejohn & McGill, 2004) were selected from the RDN/LTSN resource type vocabulary (www.rdn.ac.uk/publications/rdn-ltsn/types/). The aim was not to provide an exhaustive list of digital learning resources, but to review the landscape of resource types and outline their most positive features as well as the major problems associated with their use. Later we consider the implications of using resources within other subject disciplines.

2. Classifying learning resources

Learning resources are fundamental to good quality education; print based resources are well established as an integral part of teaching across all sectors of education and their use has evolved over a long period of time, especially in conventional, didactic modes of teaching. However, the last few decades have seen major changes, both in ideas about effective teaching methods, and in the availability and affordances of new types of resources based on digital technologies. Understanding of how to employ these new resources is still evolving and teaching staff are in the position of learners as they explore effective ways of using them. Thus, as Beetham (2002) emphasises, in characterising those resources that are effective in changing practice, it is appropriate to consider not only factors that impact on their use for teaching, but also factors that enable teachers to gain a sense of ownership of the resources and embed them in their own practice. In other words, it is the ways in which resources can be *used* by practitioners, both as learners and as teachers that are important. This duality of characteristics is particularly evident in our survey of resources that are specifically designed to change eLearning practice.

Previous studies have classified learning resources in a number of ways, depending on the purpose of the classification. A useful starting point is offered by Mayes and Fowler (Fowler & Mayes, 1999; Mayes, 2001), who focused explicitly on modes of learning. Aiming at the designers of eLearning technology Fowler and Mayes developed a cyclic framework that described three stages of learning, and associated these with three types of courseware or resource:

- Conceptualisation – coming into contact with new concepts – supported by *primary courseware* that presents information.
- Construction – building and testing one’s knowledge by performing meaningful tasks – supported by *secondary courseware* that enables interaction and structuring of material.
- Integration – externalising, performing and putting into practice what has been learnt – supported by *tertiary courseware* that enables dialogue and discussion.

In so far as this framework is intended to describe the ways staff use resources in their teaching, and in their general focus on ‘courseware’ which blurs the distinction between what are commonly held to be ‘resources’ and the ‘tools’ used to work with them, this does not help us much in understanding what makes resources effective in changing practice. However, we get further if we consider the implications of the three stage cycle treating the practitioners themselves the learners:

- Conceptualisation – practitioner sources new information or resources.
- Construction – practitioner manipulates and works out how to use the resources.
- Integration – practitioner develops resources and communicates them to the community.

These correspond closely to the six stages of resource use suggested by Beetham (2002) as shown in Table 1.

The practitioner is supported in each of these stages by a variety of tools (e.g. software for searching, editing, discussion, etc.). To be effective the characteristics of the resource need to support each stage of this cycle, and to enable use of the appropriate tools, as we discuss in the next three sections of this paper.

Table 1

Fowler and Mayes' stages of learning, and the corresponding stages of resource use by practitioners

Fowler and Mayes stage of learning	Fowler and Mayes stage of resource use	Beetham stage of resource use
Conceptualisation	Sourcing information or resources	Source a resource Use the resource for information
Construction	Manipulating and working out how to use resources	Adopt the resource into his or her own practice Repurpose the resource for reuse in new contexts
Integration	Developing and communicating resources	Develop new examples of the resource Use the resource to help others adapt their practice

First, though, we must emphasise that the term ‘learning resources’ encompasses more than simple information content. We can classify resources by their granularity, based on the work of Koper (2003, chap. 5), Rehak and Mason (2003) and Duncan (2003, chap. 2). This classification is explicit about the degree to which information content is embedded within an activity or task oriented learning context, describing four types of resources:

- Digital assets – normally a single file (e.g. an image, video or audio clip), sometimes called a ‘raw media asset’.
- Information objects – a structured aggregation of digital assets, designed purely to present information.
- Learning activities – tasks involving interactions with information to attain a specific learning outcome.
- Learning design – structured sequences of information and activities to promote learning.

The first two types may be labelled ‘information content’ and, in isolation, have no learning or teaching effect. They acquire this by being placed within learning activities or designs.

3. Sourcing learning resources

The practitioner might source, manipulate and use any of these types of resources, but from the outset an independent set of characteristics affect usability and influence uptake: representation, medium and format. Previous studies that have scoped the learning resources used by practitioners (Beetham, 2002; Sharpe et al., 2003) evidence an inconsistency in use of the word “resource”. For example, when asked for a list of resources, practitioners may list “video” alongside resources such as ‘discipline based case study’ although these are different categories of resource description, a phenomenon that is well known in the library and information domain (IFLA, 2003). In this study we characterise resources by the type of *representation of knowledge* (e.g. case study, guideline, simulation), *format* (e.g. book, database, DVD), and *medium* (e.g. text, line drawing, photograph). For example, ‘case studies’ are a type of *representation* that may be available in several types of format (for example, “book” or “video”) and media (such as “text” or “moving image”).

“Representation”, “medium” and “format” are all characteristics that affect which resources a practitioner decides to source and use. Such decisions are also strongly influenced by the educational context and community of practice within which practitioners are working. The resource must be in a format that is accessible to the teacher and his/her students, and that they can interact with. For example, practitioners working in the film and theatre domain are more likely to have the software and skills to edit a .mov file than are law lecturers. Similarly, the resource must be in a representational form and medium that has meaning for the community: a law lecturer may expect students to work regularly with textual information from articles (either print based or digital), while an engineering lecturer may find interactive simulations more valuable. At the same time, diverse educational delivery models require different formats. The law lecturer may use print based resources with campus based students, but may find digital resources more convenient for distance learning.

A significant advantage of digital resources is that they can offer flexibility of format, and ease of storage and retrieval. However, digitisation, on its own, is not enough to ensure flexibility and use. A major difficulty with early digital ‘multimedia’ resources was their inflexibility; they were not designed for reuse across a range

of contexts. Consequently resources were often based around a single educational model and made available in a set format (Thomas & Milligan, 2004).

Ease of finding suitable resources is another important factor in their effectiveness, as suggested by studies showing that the current generation of students often choose to source digital resources in preference to print based materials (Armstrong et al., 2001), and their habitual use of ‘Google’ as a primary resource search engine (Griffiths & Brophy, 2005). Among the reasons given for these preferences are that the computer terminal provides a ‘one stop shop’ for resources, and that while Google may not provide the best quality information or most efficient search, it is familiar and has a track record of producing results that are adequate. Similar criteria of unified access, familiarity and adequacy seem likely to apply to teachers’ strategies in sourcing resources.

4. Manipulating and using learning resources

While representation, medium and format influence the communities within which a learning resource might be used, the way in which it is used is not fully determined by these characteristics.

Manipulation and interaction are key aspects of effective learning resources: by interaction practitioners construct their own understanding and use of the resource; and by embedding digital assets or information objects into an interactional framework, practitioners give them educational purpose and value, producing learning activities or designs.

A useful framework for exploring the issues is Laurillard’s *Conversational Model* (2002) which offers five ways in which learning resources may be used: narrative, interactive, adaptive, communicative and productive. Most learning resources can be matched against more than one of the five categories, depending on their use. For example, a set of PowerPoint slides could provide the information content at the heart of learning activities representing all five forms:

- narrative – if downloaded by the learner from a website or database;
- communicative – if used as the basis for a discussion;
- interactive – if searched or scanned for bibliographic entries;
- adaptive – if edited with PowerPoint software; and
- productive – if the ideas from the slides are used as the basis for reconceptualisation using concept mapping software.

Thus this classification defines the types of interaction that students or practitioners might have with the resource. To be effective, the resource must be in a format that can be manipulated using the tools available. Table 2 suggests interactions and tools that might support Laurillard’s forms for the PowerPoint example. An extensive review of tools available to support working with learning resources has been carried out by Britain (2004).

Laurillard’s emphasis on types of interaction highlights the crucial link between learning and activity: information is used during student learning activities as trigger for both internal (inner mental) and external dialogue (with tutors and peers). Learners construct their own knowledge through these interactions with tutors,

Table 2

Laurillard’s differing forms of resource result from different types of user interaction with the resource, and might be applicable at different stages of Fowler and Mayes’ cycle of learning

Resource	Example of interaction and tool used	Laurillard form	Fowler and Mayes stage
PowerPoint presentation	View from a database	Narrative	Conceptualisation
	Search for key word with MS tool	Interactive	Construction
	Edit with MS tool	Adaptive	
	Discuss in online forum	Communicative	
	Interpret with concept mapping tool	Productive	Integration

other students and with the learning materials (Palinscar, 1998). Tutors usually plan how to link information content with activities in ‘lesson plans’ or learning designs, making decisions based on the stage of a learning cycle they want to support, and their pedagogical approach.

Recently, notational learning design specifications have been developed, that can link student activities and information content for electronic generation within a Virtual Learning Environment (Liber & Olivier, 2003). The IMS Learning Design specification, for example, defines course designs in terms of *context* (subject, level, educational approach and environment), student *activities* (or tasks) and *roles* (for example group moderator, reporter etc.). To support the activities the VLE will provide students with access to resources in a variety of formats and media.

5. Developing and communicating new resources

The increasing emphasis on learning design is raising awareness of the importance of being able to adapt resources into new forms, and communicate and reuse them to support different kinds of activities within different contexts. Enabling practitioners and learners to aggregate digital, granular resources can potentially help meet the competing requirements of Higher Education, by making resources available to large numbers of students while allowing different packages of resources to suit particular needs. For example, an animation file might be substituted by another file in a more accessible format for students with disabilities. Similarly, aggregation offers the possibility of ‘personalised’ learning systems that identify learners’ skills levels and present them with materials aimed at their current abilities.

Collis and Strijker (2004), emphasising the role of the practitioner in adapting resources to particular contexts have described three types of resources, *pure*, *pure combined*, and *adapted* resources:

- *Pure resources* are unedited and are the most commonly used electronic materials in UK Higher Education (Britain & Liber, 2004). Examples include articles, book chapters, illustrations and animations as well as self generated materials such as PowerPoint slides and course notes.
- *Pure, combined resources* are unedited resources that have been combined with other resources. Typically, this will be an information resource (such as a course reading) combined with a learning activity. Examples include an online or face-to-face discussion, an essay writing task or a calculation. Activities are often generated by the tutor and allow contextualisation of the resource.
- *Adapted resources* have been repurposed from an original source; teachers frequently contextualise resources by adapting existing materials to fit specific teaching contexts. How easy this is depends on a number of factors. For example, resources which can be edited using widely available software are more easily adapted than those requiring special software.

Mayes (1995) has pointed out that the outcomes of learning activities may themselves be used as pure or adapted resources by succeeding cohorts of students. For example, a student essay may subsequently be used by later student cohorts as the basis for critical reflection on the qualities of a good essay. However, adaptation is often necessary to make materials that have been spontaneously generated, reusable and easily interpretable by the user (SCROLLA, 2003). For example, rather than allowing access to a raw discussion forum, the discussion outputs could be presented as groupings of ideas around specific concepts (see Fig. 1) or threaded lists highlighting inputs from particular individuals (see Fig. 2).

Providing context may sometimes be achieved by a relatively simple combination of decontextualised resources. Duncan (2003, chap. 2) gives the example of an image of Van Gogh’s “Sunflowers” painting which may be combined with information outlining the artist’s technique for use in Art education. Alternatively if the image is combined with information about sunflowers, it may be used for Horticulture education.

Following this basic model, reusable learning resources have been conceptualised as blocks of content, or ‘Learning Objects’, that could be plugged together to produce a course (Downes, 2000). Analogous to LEGO bricks, resources could be recombined with other resources and reused in different courses. The LEGO view of Learning Objects has been rejected by Wiley (2000) as encouraging a simplistic view of learning resources, and a narrow view of education as transmission of blocks of content. He has proposed an alternative metaphor: that of a chemist combining atoms to form molecules. Wiley argues that this analogy improves on the LEGO

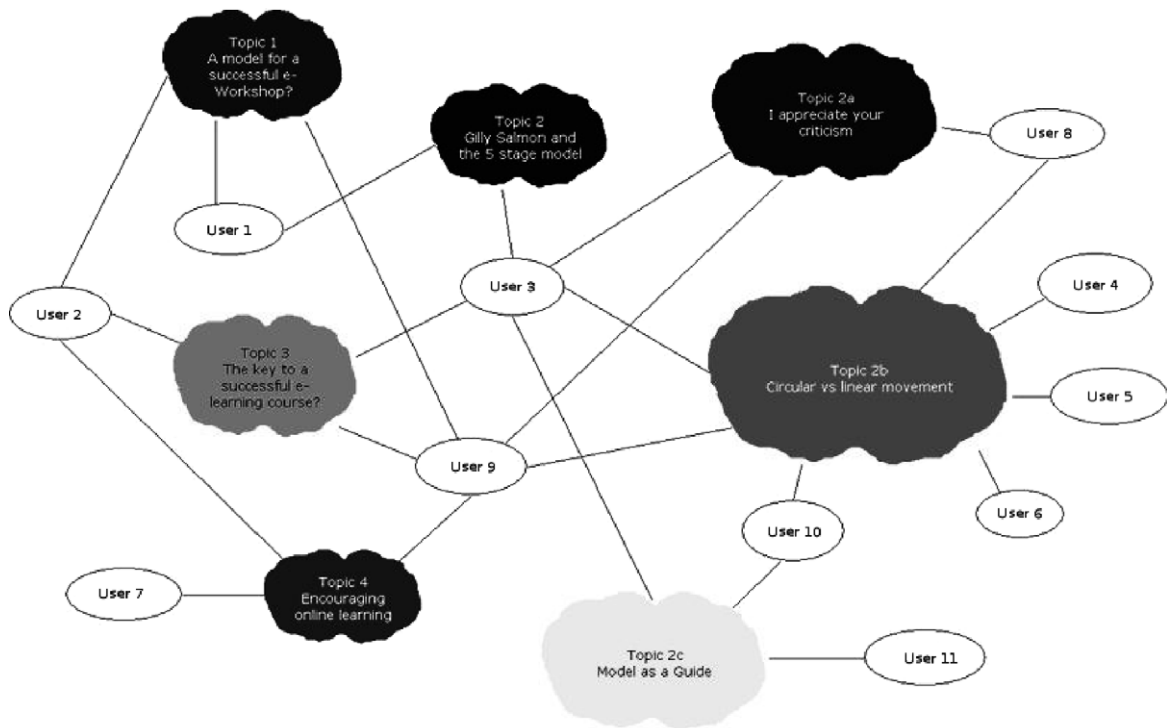


Fig. 1. An online discussion presented as groupings of ideas around specific concepts. Reproduced from Muirhead, A. (2003) Repacking of Learning Discussions in the Virtual Learning Space Discussions. Report to the Scottish European Social Fund on model design and development work by Glenaffric Ltd for the Scottish Centre for Research into On-Line Learning and Assessment. © SCROLLA www.scrolla.ac.uk.

model in three main ways. Firstly, not every resource can combine with every other, just as not every atom will combine with every other atom. Secondly, resources combine in such a way as to form useful structures – just as atoms combine to form molecular structures. Thirdly, combining resources requires training. Wiley highlights a significant issue: it is important to consider the ways in which resources can be combined, rather than thinking about them only as individual objects. This adds a layer of complexity to any consideration of resources.

Following his emphasis on combination, Wiley's (2000) taxonomy focuses on the ways in which resource components are combined electronically for reuse, and contrasts with Collis and Strijker's concentration on teacher adaptation. He describes resources as fundamental (uncombined with any other); combined closed (aggregated resources that are not individually accessible); combined open (groups of resources that are digitally combined such as texts grouped together 'on the fly' within a webpage); generative presentational (resources that generate and present simple content or a single activity, for example a JAVA applet) and generative instructional (resources that are automatically combined into an instructional sequence through a transaction shell such as IMS Learning Design), as shown in Table 3.

Developing Wiley's point that resources may be electronically assembled and structured from components, and Mayes' that the cumulative outcomes of collaboration may be a very effective resource, we add a fourth type of resource to Collis and Strijker's three:

- *Dynamic resources* are electronically assembled and structured, and allow interaction and contribution. As well as Wiley's generative instructional class, examples would include: the responses to articles within the Journal of Interactive Media in Education (<http://www.jime.open.ac.uk/2003/1/>) where commentaries are linked to journal articles providing a rich, dynamic resource; Wikis (web pages that can be edited by multiple users); and Blogs.

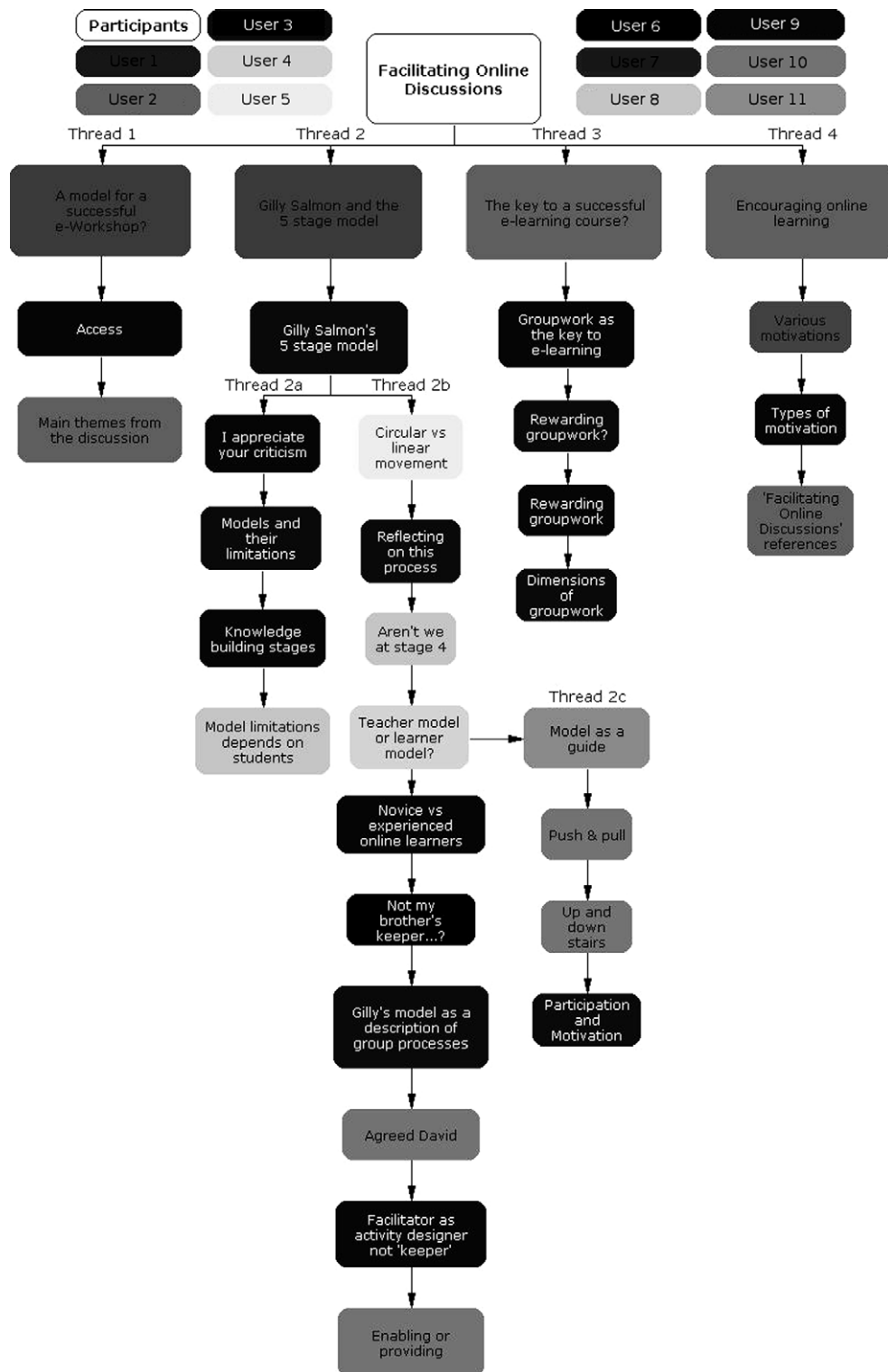


Fig. 2. An online discussion presented as threaded lists highlighting inputs from individuals in different shades. Reproduced from Muirhead, A. (2003) Repackaging of Learning Discussions in the Virtual Learning Space Discussions. Report to the Scottish European Social Fund on model design and development work by Glenaffric Ltd for the Scottish Centre for Research into On-Line Learning and Assessment. © SCROLLA www.scrolla.ac.uk.

Table 3

Component types in Wiley's taxonomy of learning resources, adapted from Wiley (2000)

Learning Object Characteristic	Fundamental Learning Object	Combined-closed Learning Object	Combined-open Learning Object	Generative-presentation Learning Object	Generative-instructional Learning Object
Number of elements combined	One	Few	Many	Few–Many	Few–Many
Type of component objects	Fundamental	Fundamental, Combined-closed	All	Fundamental, Combined-closed	Fundamental, Combined-closed, Generative-presentation
Reusable component objects	(Not applicable)	No	Yes	Yes/No	Yes/No

6. Analysis of resources known to have influenced practice

Our review of specific resources that have had a positive influence on changing e-learning practice within the UK learning technology community was based on four indicators of impact (Littlejohn & McGill, 2004): common use amongst practitioners, positive evaluation documentation, regular citations within the literature, and widespread adoption within accredited courses. A full survey of resource usage across a range of disciplines was beyond the scope of the study, but a brief list of resources used in chemistry was drawn up for comparison with eLearning. The resources and their characteristics are shown in Tables 4 and 5.

Based on this survey we have identified 12 key characteristics shown by effective learning resources. These characteristics are pragmatic, and evidence-based, and cut across the classifications of resource characteristics discussed in previous sections. As well as technical issues of format and potential for adaptation or combination, they recognise cultural issues that have been documented elsewhere, such as cost, and intellectual property rights (IPR). Fig. 3 suggests how the 12 characteristics can be mapped against Sharpe's (2004) five guiding principles essential to good e-learning practice: usability, working within communities, contextualisation, promoting professional learning, and promoting good learning design. It also suggests the stage of resource use, and level of adaptability or reuse at which these characteristics become important.

Describing these characteristics in more detail:

Resources are likely to have high *usability* if:

- the materials can be *easily sourced*;

All of the representations included within the analysis could be easily sourced by tutors. Many of them are advertised through staff development activities. Ensuring ease of sourcing entails associating resources with 'metadata' describing their potential use as well as classification information. This is time consuming for resource authors to provide and requires an understanding of the complexities not only of the subject discipline, but also of the classification system being used. Whilst librarians have traditionally applied metadata to both physical and digital resources, there is much debate about who should produce metadata for Learning Objects (Currier, 2002). Although teachers and students, as users, need not be aware of these metadata issues they do need to understand how resources are indexed or classified and the taxonomic terms used, in order to search for and locate them. This raises issues of information literacy levels of both teachers and students.

- the resources are *durable and maintained*;

Although some of these resources are not currently being maintained, they were all available from sources that are being maintained, often by national organisations. Tutors are likely to feel more confident in referencing content in an eJournal than material on an unsupported website. This is closely related to the next factor.

- the resources have a degree of *quality assurance*;

Most of the representations were associated with a national organisation or publisher and, as such, have a degree of quality assurance associated with them.

Table 4
Characteristics of resources that have affected e-learning practice

Resource	Representation	Target users	Format/medium	Key characteristics	Issues
LTSN e-learning guides	Guidelines	Each guide aimed at a specific group: managers, learning technologists, support staff, teachers, etc.	PDF available from LTSN website (also distributed as printed guides)	Language accessible to target user group Accessible format Contains activities Durable Freely available Fairly easy to source Associated with national org	No commitment to updating
E-moderating	Activities	Teachers, a range of support staff (widely adopted as course text)	Textbook	Accessible language Accessible format Contains activities Durable Easy to source Associated with reputable publisher Associated, free online resources	Educational model open to criticism Purchased or loaned from library
Evaluation cookbook	Case studies, toolkit,	Teachers, a range of support staff (widely adopted as course text)	Printable PDF version or interactive HTML version available from LDTI website Also available as a printed booklet www.icbl.hw.ac.uk/ltidi/cookbook/	Presents evaluation methods in a clear, concise manner Accessible language Accessible format Durable: website maintained Freely available Easy to source Assoc with national org	Approaches to evaluation may be over simplified(?) Resources not updated – though methods still valid (not locked into an approach or technology)
OTiS case studies	Case studies	Teachers, a range of support staff (incorporated into staff development course websites) These resources were cited in the ScotCIT programme evaluation as being widely used for staff development. www.glenaffric.co.uk/docs/scotcit.pdf	Available as HTML or as an e-book from ScotCIT website www.otis.scotcit.ac.uk	Presents case studies with a degree of contextualisation relevant to practitioners. Wide range of case studies Accessible format Durable: website maintained Freely available Easy to source Assoc with national org	Language not entirely accessible Resources not updated

(continued on next page)

Table 4 (continued)

Resource	Representation	Target users	Format/medium	Key characteristics	Issues
ELICIT modules	Activities, case studies,	Mainly staff developers These resources were cited in the ScotCIT programme evaluation as being widely used for staff development (www.glenaffric.co.uk/docs/scotcit.pdf). They have been incorporated into staff development course websites	HTML or .doc versions available from ScotCIT website www.sesdl.scotcit.ac.uk	Content and activity resource materials for use in a variety of staff development contexts. Can be repurposed/ recontextualised for use in local institutions Accessible format Fairly accessible language Durable: website maintained Freely available Easy to source Assoc with national org	Repurposing materials requires considerable time investment Resources not updated
JISC Info KITS	Toolkits, reports, case studies, supporting materials	Teachers, a range of support staff, technical staff, managers	HTML version available from JISC website	Accessible format Fairly accessible language Durable: website maintained Freely available Easy to source Assoc with national org Activities	“Modular” structure – designed to be read from a screen. – whole InfoKIT cannot be easily downloaded or printed Difficult to repurpose/ recontextualise for use in local institutions
JIME articles	Articles, reviews	Teachers, educational researchers, support staff	Available as HTML or PDF from JIME/OU website http://www.jime.open.ac.uk/	Accessible format Fairly accessible language Durable: website maintained Freely available Fairly easy to source Assoc with OU Readers can add comments – therefore ideas can be debated and/or updated	Can be difficult to encourage responses
Effective lecturing	Case studies	Staff development resources that can be incorporated into workshops or used as standalone	Case studies available on videotape or DVD. Text and video resources available from http://www.gla.ac.uk/services/tls/STAFF/ras/ELPwebpage/project/	Accessible format Accessible language Freely available Fairly easy to source Assoc with ScotCIT Practitioners can build on existing practice	

Table 5
Characteristics of resources that have affected practice in chemistry teaching

Resource	Representation/ resource type	Target users	Format/medium	Key characteristics	Issues
Crystallographic data from Cambridge database	Datasets (not included in RDN/LTSN classification)	Chemistry lecturers and students	Datasets can be uploaded into associated allowing molecules to be drawn and data to be manipulated	Data can be incorporated into student activities Durable Freely available Fairly easy to source Associated with national org	
Images sources through LTSN	CHIME images	Chemistry lecturers, teaching assistants and students	Interactive images	Images can be manipulated during student activities Durable Freely available Fairly easy to source Associated with national org	
General textbooks	Textbook	Chemistry lecturers, teaching assistants and students	Textbook	Durable Available at low cost Easy to source Associated with publisher	

- the resources are *free from legal restrictions*;

Many of the resources had been produced specifically for use by the educational community and, therefore, are generally free from legal restrictions related to Intellectual Property Rights (IPR). However, studies have

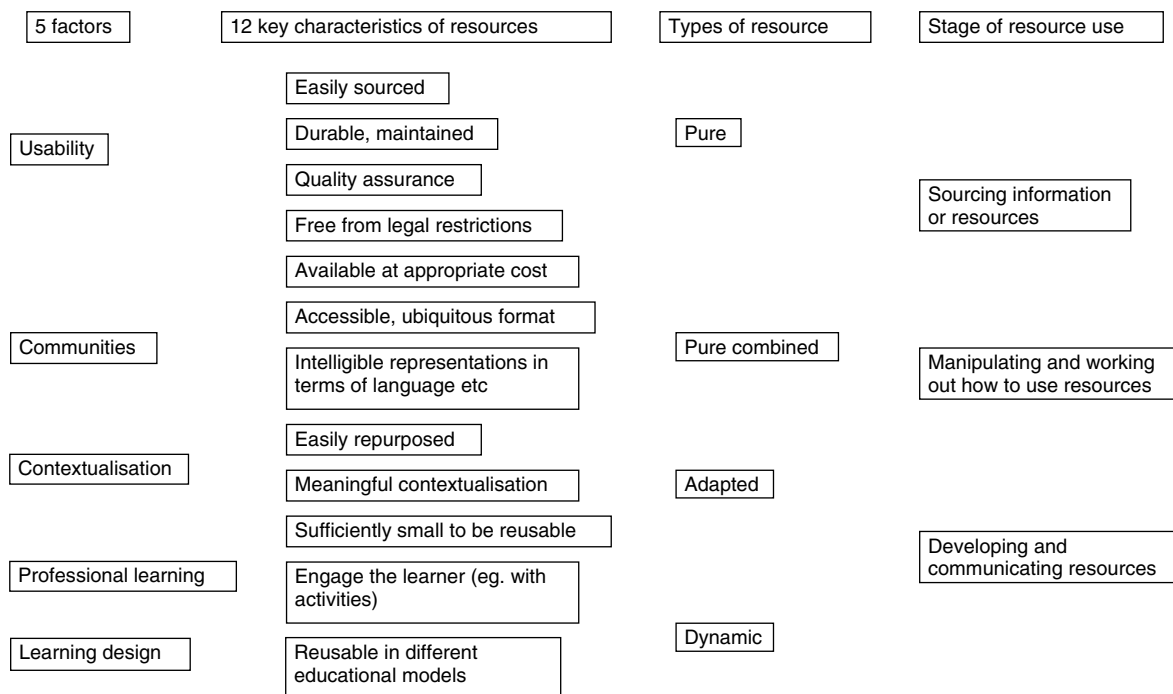


Fig. 3. Factors likely to influence positively the use of a resource.

shown reluctance among academics to submit individually authored resources to a digital repository (Campbell, Littlejohn, & Duncan, 2001). This is related to the fact that there is insufficient reward (financial or kudos) for them to do so. Moreover, copyright law is often compromised as many tutors and students are reusing digital resources without a clear understanding of the copyright situation.

- the resources are available at an *appropriate cost*;

Each of these resources was either freely available from a national organisation or funded initiative, or could be purchased at a reasonable price. Many of the resources available through the UK Learning and Teaching Support Network (now superseded by the Higher Education Academy Subject Centres) have a cost which may prohibit their widespread use. However, it is possible that resources at appropriate cost will be adopted if other factors (for example accessibility of language) render them appealing to tutors and students.

The key elements that render a resource useful to tutors are not simply a function of those resources themselves, but are related to the communities in which they are being used, the learning context and issues surrounding reuse and adaptation.

Resources are likely to be adopted by *communities* if:

- they are in *formats that are accessible and ubiquitous* within that community;
All the resources were in widely used electronic formats or print.

- the resources are in *media that present intelligible representations in terms of language etc.*

The resources were all couched in accessible or fairly accessible language or represented as types of images that are familiar to the target group (in the case of chemistry). Most of them were prepared specifically for the target communities.

Furthermore, to be more widely usable, outside the originating community, it is important that resources can be *contextualised* for new communities by being:

- *Easily repurposed*;

Many of the effective resources appeared not to meet the criterion of being easily repurposed. In principle, for repurposing, learning resources should not contain information specific to a particular context (Naeye, 1999). However, this contradicts the way that teachers normally adapt resources from highly contextualised accounts to fit specific teaching situations (Thorpe, Kubiak, & Thorpe, 2003). There is a tension between the requirement of decontextualisation for repurposing, and the need to retain context to enable the teacher to understand the resource. The disadvantage of not being easily repurposed is apparently outweighed by the benefit of contextualisation or of saving time in aggregation.

- *Of a critical 'size'*;

Resources should be sufficiently small to be reusable, but large enough to ensure that tutors do not have to spend time aggregating large numbers of resources. In general, the more granular a resource, the greater the possibility of it being re-used in another context: for example, an individual image is likely to be more readily reused than an entire course (Downes, 2000). However, aggregated resources may have intrinsically greater educational value (Thorpe et al., 2003) and it may be less time consuming for a teacher to reuse a single, larger resource, than to construct a course from many basic components.

Changing practice requires practitioners to engage with new ideas. They may wish to adopt various approaches to learning and teaching and require resources to support the different types of interaction suggested by Laurillard. This applies particularly if teachers are trying to move away from a narrative presentation of information towards a more active use. Thus resources should:

- be presentable in a *context that is meaningful* for the practitioner;

Most of the resources were aimed at specific target user groups and were presented within a context that makes sense to those users. Case studies, which are necessarily contextualised, were notably popular. Resources used by the learning technology community are available in a seemingly limited range of media types, the vast majority being text based. Other subject disciplines, such as Science and Engineering, may

benefit from a wider variety of visual and aural representations, such as video case studies, which may offer the tutor a more realistic perspective, offering illuminative “war stories” presented by peers, and providing the incentive to move from being “informed by” to “adopting” new approaches to teaching (Beetham, 2004).

- show how they will *engage the learner* (for example by using appropriate learning activities).

Many of the resources either suggested activities, or were in a format that enables the learner to engage and do something active with them (for example, manipulating images).

As the concept of active learning resources and their sequencing within a learning design or lesson plan becomes more prominent, the profile of dynamic resources is likely to increase: resources will need to show how they can be:

- *reused in a range of educational models* or learning designs.

This is little evidence in our survey of resources being used in this way at present. This characteristic is likely to be strongly influenced by the community within which resources originate, and warrants further study.

7. Conclusion

This study has identified 12 key characteristics of resources that may promote changes in e-learning practice. The resources considered have primarily been “pure” resources, and we have little information about whether they were adapted by teaching staff in use.

The columns in Fig. 3 appear to relate in a linear way: the guiding principles, the 12 key characteristics that render a resource useful and the classifications of resources. However, resources in e-learning environments need not be static. When a pure resource is adapted then the ownership characteristics may change.

Pure resources – Need to be accessible and authentic to the tutor. At the same time, the user has to feel a degree of ownership of the resource which enhances understanding and eliminates the ‘not invented here’ syndrome. The degree of ownership felt is likely to increase when the tutor adapts a resource for a use within a specific context.

Pure, combined resources – Tutors need to be supported in combining representations (for example combining an activity with information content), particularly when constructing learning designs. A second useful way of associating different resources could be the use of “multi level representations” (Beetham, 2004) to provide associated representations at different levels, offering the student a choice of the level of resource they want to use. In addition, association is a useful way of providing a range of resources suitable for students with special needs.

Adapted resources – Many tutors adapt resources to fit their own teaching context on a daily basis. This analysis has identified two issues. Firstly there is a tension between the potential educational benefits of making resources available in a wide variety of formats with the ability of tutors to adapt these. Secondly, there may be an inverse relationship between resources being sufficiently large to be of educational value, while being small enough to reuse effectively.

Dynamic resources – Use of dynamic resources is still in its infancy, but is likely to grow rapidly. Being able to contribute to a resource not only embraces constructivist principles, but may alter feelings towards ownership. This linking of representations often requires an association of resource types and tools, for example content, activity, and a learning design player.

Whilst one can apply these criteria to any resource and conclude that it may be effective, it is apparent that a characteristic such as ‘free from legal restrictions’ may only be true within a particular context. For example an electronic journal may be free from legal restrictions to all students with a campus based IP address but will not be accessible from home or for distance learning students working from another country. What may be a positive accessibility characteristic in one situation may be a barrier in another, even for the same subject area and teacher. In fact the authors contend that these criteria should not be applied to a resource divorced from a learning and teaching context. They should not be applied by ‘experts’ or even the resource authors, but must, to be useful, be applied by ‘tutors’ within their own context/s.

Currently many tutors start by focussing on content and may appreciate guidance in the choice of resource format, medium etc., as well as in consideration of educational design and learner activities through determining

the suitability of resources for their teaching. Guidelines could give tutors opportunities to approach the use of resources from their chosen perspective while, at the same time, encourage them to consider further ways enhance learning. One approach could be to support the tutor in considering how he/she intends to use a resource (ie as a pure, pure/combined, or adapted resources in the creation of active resources). This initial decision could lead the tutor towards considering which of the characteristics identified by this study are critical to his or her resource use. Work following on from this study has developed a *typology* or matrix, mapping key principles that render a resource effective (e.g. accessibility, contextualisation, etc.) against a range of interventions (resources, tools and services). The matrix structure illustrates how important characteristics might operate within the context of working with resources, individuals and groups for wider change in e-learning. This typology can be used as a tool with practitioners and/or developers to help plan e-learning practice or evaluate strategies for e-learning development (Littlejohn & McGill, 2004).

Rather than identifying what *types* of resources are effective, this study has concluded that it is their *use* in context that is important. In other words, the factors that enable or inhibit the effective use of a resource are a function not only of the representation, but of the context of use and creation. This study has moved us on from thinking about types of resources to thinking about ways in which these are generated, circulated and used.

References

- Armstrong, C., Everitt et al. (2001). JISC usage surveys: Trends in electronic information services. Strand A: A general survey of end users of all electronic information services. Strand C: A general survey of electronic information services provision. Final report 2000/2001 (cycle 2). Available from <http://www.dil.aber.ac.uk/dils/research/justeis/cyc2rep.pdf>.
- Beetham, H. (2002). Developing Learning Technology Networks Through Shared representations of Practice, Source Project Publication, PUB-OU-55.
- Beetham, H. (2004). Review for JISC pedagogy Programme, Developing e-Learning Models for the JISC Tutor Communities, Version 2.1. Available from http://www.jisc.ac.uk/elearning_pedagogy.html.
- Britain, S. (2004). A review of learning design: Concept, specifications and tools: A report for the JISC E-learning pedagogy programme. Available from http://www.jisc.ac.uk/uploaded_documents/ACF83C.doc.
- Britain, S., & Liber, O. (2004). A framework for the pedagogical evaluation of eLearning environments. JISC report. Available from http://www.cetis.ac.uk/members/pedagogy/files/4thMeet_framework/VLEfullReport.
- Campbell, L., Littlejohn, A., & Duncan, C. (2001). Share and share alike: Encouraging the reuse of academic resources through the Scottish electronic Staff Development Library, ALT-J, vol. 9, part 2.
- CIHE (2002). The Council for Industry and Higher Education, Response to the joint consultation document from HEFCE and the Learning and Skills Council. Available from <http://www.cihe-uk.com/partnershipsfor.htm>.
- Collis, B., & Strijker, A. (2004). Technology and human issues in reusing learning objects. *Journal of Interactive Media in Education*(4), Special Issue on the Educational Semantic Web. ISSN: 1365-893X. Available from www.jime.open.ac.uk/2004/4.
- Currier, S. (2002). INSPIRAL: Investigating Portals for Information Resources And Learning. Final Report. Available from <http://inspiral.cdlr.strath.ac.uk/documents/inspfinrep.doc>.
- DfES (2001). (Department for Education and Skills) Education and Skills: Delivering results a strategy to 2006, TSO, Norwich.
- Downes, S. (2000) Learning Objects. Available from http://www.newstrolls.com/news/dev/downes/column000523_1.htm.
- Duncan, C. (2003). Granularisation. In A. Littlejohn (Ed.), *Reusing online resources: A sustainable approach to eLearning*. London: Kogan Page.
- Fowler, C., & Mayes, T. (1999). Learning relationships: from theory to design. *Association for Learning Technology Journal*, 7(3), 6–16.
- Griffiths, & Brophy (2005). Student searching behaviour and the Web: Use of academic resources and Google Library Trends. Available from http://www.findarticles.com/p/articles/mi_m1387/is_4_53/ai_n14732768.
- IFLA (2003). Related efforts – Working Group on FRBR (Functional Requirements for Bibliographic Records) – Section on Cataloguing. International Federation of Library Associations and Institutions, 2003. Available from <http://www.ifla.org/VII/s13/frbr/frbr.htm>.
- Koper, R. (2003). Combining reusable learning resources and services with pedagogical purposeful units of learning. In A. Littlejohn (Ed.), *Reusing online resources: A sustainable approach to eLearning*. London: Kogan Page.
- Laurillard, D. (2002). *Rethinking university teaching* (second ed.). London: Routledge.
- Liber, O., & Olivier, B. (2003). Learning content interoperability standards. In A. Littlejohn (Ed.), *Reusing online resources: A sustainable approach to eLearning*. London: Kogan Page.
- Littlejohn, & McGill (2004). Detailed report on effective resources for e-learning. Effectiveness of resources, tools and support services used by practitioners in designing and delivering E-Learning activities – JISC E-pedagogy Programme Project. Available from <http://cetis.ac.uk:8080/pedagogy>.
- Mayes, T. (1995). Learning technology and groundhog day. In W. Strang, V. B. Simpson, & D. Slater (Eds.), *Hypermedia at work: Practice and theory in higher education*. Canterbury: University of Kent Press.

- Mayes, T. (2001). Learning technology and learning relationships. In J. Stephenson (Ed.), *Teaching and learning online: Pedagogies for new technologies*. London: Kogan Page.
- Naeve, A. (1999). Conceptual navigation and multiple scale narration in a knowledge manifold. Royal Institute of Technology, Numerical Analysis and Computing Science, Kungl Tekniska Hogskolan, Stockholm, Sweden. Available from http://cid.nada.kth.se/sv/pdf/cid_52.pdf.
- Palinscar, A. S. (1998). Social constructivist perspectives on teaching and learning. *Annual Review of Psychology*, 49, 345–375.
- Rehak, D., & Mason, R. (2003). Keeping the learning in learning objects. In A. Littlejohn (Ed.), *Reusing online resources: A sustainable approach to eLearning*. London: Kogan Page.
- SCROLLA (2003). The Virtual Learning Space Project Report. Available from <http://www.scrolla.ac.uk/post/000062.html>.
- Sharpe (2004). A typology of effective interventions that support e-learning practice. Available from http://www.jisc.ac.uk/uploaded_documents/typology%20v3.1.doc.
- Sharpe, Beetham & Ravenscroft (2003). Using active representations of knowledge to support tutors to change their practice. In *8th Annual SEDA conference in Birmingham, November 2003*.
- Thomas, R., & Milligan, C. (2004). Putting teachers in the loop: tools for creating and customising simulations. *Journal of Interactive Media in Education*, 15, Designing and Developing for the Disciplines (Special Issue). Available from www.jime.open.ac.uk/2004/15.
- Thorpe, M., Kubiak, C., & Thorpe, K. (2003). Designing for reuse and versioning. In A. Littlejohn (Ed.), *Reusing online resources: A sustainable approach to eLearning*. London: Kogan Page.
- Wiley, D. A. (2000). Connecting Learning Objects to instructional design theory: a definition, a metaphor, and a taxonomy. In D. A. Wiley (Ed.), *The instructional use of Learning Objects*. Available from <http://reusability.org/read/chapters/wiley.doc>.